

WHAT IS CLAIMED IS:

1. A method of converting non-hypoxic cells into hypoxic cells, comprising:
  - a) impeding oxygen supply to non-hypoxic cells in a subject in need thereof by using a magnetic fluid.
2. The method of Claim 1, wherein:
  - the step a) comprises blocking a blood vessel feeding to the non-hypoxic cells.
3. The method of Claim 2, wherein:
  - the step a) comprises delivering a magnetic fluid adjacent the non-hypoxic cells and applying a magnetic field to join a plurality of particles in the magnetic fluid to form a blockage in the blood vessel thereby impeding the flow of oxygen to the non-hypoxic cells.
4. The method of Claim 3, wherein:
  - the magnetic fluid is delivered through a catheter or by injection.

5. The method of Claim 3, wherein:
  - the magnetic field is applied by an internal micromagnet,
  - an external rare earth magnet, or an external electromagnet.
6. The method of Claim 3, wherein:
  - the magnetic fluid comprises core particles of a magnetic material.
7. The method of Claim 6, wherein:
  - the core particles comprise coated particles.
8. The method of Claim 6, wherein:
  - the core particles have an average diameter of about 1 nm to 20  $\mu\text{m}$ .
9. The method of Claim 8, wherein:
  - the core particles have an average diameter of about 10 nm to 5  $\mu\text{m}$ .

- 10. The method of Claim 9, wherein:
  - the core particles have an average diameter of about 10 nm to 1,000 nm.
- 11. The method of Claim 6, wherein:
  - the magnetic material is selected from the group consisting of iron, iron oxide, cobalt, cobalt oxide, nickel, nickel oxide, an alloy, and a combination thereof.
- 12. The method of Claim 6, wherein:
  - the core particles comprise a coating of a surfactant.
- 13. The method of Claim 12, wherein:
  - the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.
- 14. The method of Claim 6, wherein:
  - the core particles comprise a coating selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.

15. The method of Claim 14, wherein:
- the coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.
16. The method of Claim 6, wherein:
- the core particles comprise first and second successive coatings.
17. The method of Claim 16, wherein:
- the first coating comprises a coating of a surfactant; and
- the second coating comprises a coating of a material selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.
18. The method of Claim 17, wherein:
- the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.

19. The method of Claim 18, wherein:
- the second coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.
20. The method of Claim 8, wherein:
- the core particles are dispersed in a carrier fluid.
21. The method of Claim 20, wherein:
- the carrier fluid comprises a water-based carrier fluid.
22. The method of Claim 20, wherein:
- the carrier fluid is selected from the group consisting of water, Ringer's solution, normal saline, sugar solution, blood plasma, and a combination thereof.
23. The method of Claim 20, wherein:
- the fraction of the core particles is about 1-90%.

24. The method of Claim 8, wherein:

the core particles comprise a general shape selected from the group consisting of spherical, needle-like, cubic, irregular, cylindrical, diamond, oval, and a combination thereof.

25. A method of inducing hypoxia in a non-hypoxic region of a tumor, comprising the steps of:

- a) administering a magnetic fluid in a subject in need thereof through a blood vessel feeding a tumor; and
- b) applying a magnetic field adjacent the tumor to join a plurality of particles in the magnetic fluid to form a blockage in the blood vessel thereby impeding the flow of blood to the tumor.

26. The method of Claim 35, wherein:

the magnetic fluid in step a) is delivered through a catheter or by injection.

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- 27. The method of Claim 25, wherein:
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  - the magnetic field in step b) is applied by an internal micromagnet, an external rare earth magnet, or an external electromagnet.
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- 28. The method of Claim 25, wherein:
  - the magnetic fluid comprises core particles of a magnetic material.
- 29. The method of Claim 28, wherein:
  - the core particles comprise coated particles.
- 30. The method of Claim 28, wherein:
  - the core particles have an average diameter of about 1 nm to 20  $\mu\text{m}$ .
- 31. The method of Claim 30, wherein:
  - the core particles have an average diameter of about 10 nm to 5  $\mu\text{m}$ .

32. The method of Claim 31, wherein:
- the core particles have an average diameter of about 10 nm to 1,000 nm.
33. The method of Claim 28, wherein:
- the magnetic material is selected from the group consisting of iron, iron oxide, cobalt, cobalt oxide, nickel, nickel oxide, an alloy, and a combination thereof.
34. The method of Claim 28, wherein:
- the core particles comprise a coating of a surfactant.
35. The method of Claim 34, wherein:
- the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.
36. The method of Claim 28, wherein:
- the core particles comprise a coating selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.



37. The method of Claim 36, wherein:

the coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.

38. The method of Claim 28, wherein:

the core particles comprise first and second successive coatings.

39. The method of Claim 38, wherein:

the first coating comprises a coating of a surfactant; and

the second coating comprises a coating of a material selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.

40. The method of Claim 39, wherein:

the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.

41. The method of Claim 40, wherein:
- the second coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.
42. The method of Claim 30, wherein:
- the core particles are dispersed in a carrier fluid.
43. The method of Claim 42, wherein:
- the carrier fluid comprises a water-based carrier fluid.
44. The method of Claim 42, wherein:
- the carrier fluid is selected from the group consisting of water, Ringer's solution, normal saline, sugar solution, blood plasma, and a combination thereof.
45. The method of Claim 42, wherein:
- the fraction of the core particles is about 1-90%.

46. The method of Claim 30, wherein:

the core particles comprise a general shape selected from the group consisting of spherical, needle-like, cubic, irregular, cylindrical, diamond, oval, and a combination thereof.

47. A method of treating a tumor, comprising the steps of:

- a) administering a magnetic fluid in a subject in need thereof through a blood vessel feeding a tumor;
- b) applying a magnetic field adjacent the tumor to join a plurality of particles in the magnetic fluid to form a blockage in the blood vessel thereby impeding the flow of blood to the tumor; and
- c) continuing with step b) for a sufficient time to induce hypoxia in a non-hypoxic region of the tumor.

48. The method of Claim 47, further comprising the step of:

- d) administering a hypoxic drug prior to or after step a), or substantially simultaneously therewith.

49. The method of Claim 48, wherein:

the hypoxic drug is selected from the group consisting of AQ4N, mitomycin C, porfiromycin, and tirapazamine.

50. The method of Claim 47, wherein:  
the magnetic fluid is delivered through a catheter or by injection.
51. The method of Claim 47, wherein:  
the magnetic field is applied by an internal micromagnet, an external rare earth magnet, or an external electromagnet.
52. The method of Claim 48, wherein:  
the hypoxic drug is administered through a catheter, by injection, or intravenously.
53. The method of Claim 47, wherein:  
the magnetic fluid comprises core particles of a magnetic material.
54. The method of Claim 53, wherein:  
the core particles comprise coated particles.

55. The method of Claim 53, wherein:
- the core particles have an average diameter of about 1
  - nm to 20  $\mu\text{m}$ .
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56. The method of Claim 55, wherein:
- the core particles have an average diameter of about 10
  - nm to 5  $\mu\text{m}$ .
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57. The method of Claim 56, wherein:
- the core particles have an average diameter of about 10
  - nm to 1,000 nm.
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58. The method of Claim 53, wherein:
- the magnetic material is selected from the group
  - consisting of iron, iron oxide, cobalt, cobalt oxide, nickel, nickel
  - oxide, an alloy, and a combination thereof.
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59. The method of Claim 53, wherein:
- the core particles comprise a coating of a surfactant.
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60. The method of Claim 59, wherein:

the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.

61. The method of Claim 53, wherein:

the core particles comprise a coating selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.

62. The method of Claim 61, wherein:

the coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.

63. The method of Claim 53, wherein:

The core particles comprise first and second successive coatings.

64. The method of Claim 63, wherein:
- the first coating comprises a coating of a surfactant; and
  - the second coating comprises a coating of a material selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.
65. The method of Claim 64, wherein:
- the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.
66. The method of Claim 65, wherein:
- the second coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.
67. The method of Claim 55, wherein:
- the core particles are dispersed in a carrier fluid.
68. The method of Claim 67, wherein:
- the carrier fluid comprises a water-based carrier fluid.

69. The method of Claim 67, wherein:

the carrier fluid is selected from the group consisting of water, Ringer's solution, normal saline, sugar solution, blood plasma, and a combination thereof.

70. The method of Claim 67, wherein:

the fraction of the core particles is about 1-90%.

71. The method of Claim 55, wherein:

the core particles comprise a general shape selected from the group consisting of spherical, needle-like, cubic, irregular, cylindrical, diamond, oval, and a combination thereof.

72. A kit for treating a tumor, comprising:

- a) a quantity of core particles of a magnetic material;
- b) the core particles having an average diameter of about 1 nm to 20  $\mu\text{m}$ ; and
- c) a device for generating a magnetic field.



73. The kit of Claim 72, further comprising:
- a) instructions for using the kit.
74. The kit of Claim 72, wherein:
- a) the device comprises an internal micromagnet, an external rare earth magnet, or an external electromagnet.
75. The kit of Claim 72, wherein:
- a) the core particles comprise coated particles.
76. The kit of Claim 72, wherein:
- a) the core particles have an average diameter of about 10 nm to 5  $\mu\text{m}$ .
77. The kit of Claim 76, wherein:
- a) the core particles have an average diameter of about 10 nm to 1,000 nm.
78. The kit of Claim 72, wherein:
- a) the magnetic material is selected from the group consisting of iron, iron oxide, cobalt, cobalt oxide, nickel, nickel oxide, an alloy, and a combination thereof.

79. The kit of Claim 72, wherein:
- a) the core particles comprise a coating of a surfactant.
80. The kit of Claim 79, wherein:
- a) the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.
81. The kit of Claim 72, wherein:
- a) the core particles comprise a coating selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.
82. The kit of Claim 81, wherein:
- a) the coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.

83. The kit of Claim 72, wherein:

- a) the core particles comprise first and second successive coatings.

84. The kit of Claim 83, wherein:

- a) the first coating comprises a coating of a surfactant; and
- b) the second coating comprises a coating of a material selected from the group consisting of a ceramic material, a metallic material, a polymer material, and a combination thereof.

85. The kit of Claim 84, wherein:

- a) the surfactant is selected from the group consisting of polyethylene oxide, dextran, a Pluronic<sup>®</sup> surfactant, and a combination thereof.

86. The kit of Claim 85, wherein:

- a) the second coating is selected from the group consisting of silica, gold, silver, platinum, steel, cobalt, carbon, polyethylene glycol, dextran, Tween<sup>®</sup>, sorbitol, mannitol, and a combination thereof.

87. The kit of Claim 72, wherein:

- a) the core particles are dispersed in a carrier fluid.

88. The kit of Claim 87, wherein:

- a) the carrier fluid comprises a water-based carrier fluid.

89. The kit of Claim 87, wherein:

- a) the carrier fluid is selected from the group consisting of water, Ringer's solution, normal saline, sugar solution, blood plasma, and a combination thereof.

90. The kit of Claim 87, wherein:

- a) the fraction of the core particles is about 1-90%.

91. The kit of Claim 72, wherein:

- a) the core particles comprise a general shape selected from the group consisting of spherical, needle-like, cubic, irregular, cylindrical, diamond, oval, and a combination thereof.